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EXCHANGE RATE PASS-THROUGH TO DOMESTIC INFLATION IN HONG KONG

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Abstract

This paper estimates pass-through of exchange rate changes to domestic inflation in Hong Kong in a two-step approach. We first estimate exchange rate pass-through to import prices and then from import price to domestic inflation using a Phillips-Curve model. We find that Hong Kong's exchange rate pass-through to import prices is relatively high compared to the OECD average, although Hong Kong also witnessed a decline of pass-through after 1991. With respect to exchange rate pass-through to domestic prices, we find that a 10% depreciation of the US dollar against all currencies except for the Hong Kong dollar would lead domestic prices to increase by 0.82 and 1.61 percent in the short run and medium run, respectively. These results are also broadly consistent with those obtained from a calibration exercise that estimates exchange rate pass-through to domestic prices via channels of the tradable and non-tradable goods.

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Keywords: Exchange rate pass-through, Phillips Curve, Hong Kong

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Executive Summary:

- *Using a standard exchange rate pass-through model, we first estimate exchange rate pass-through to import prices in Hong Kong. The estimated elasticities of exchange rate pass-through to import prices are around 0.33 in the short run (next quarter) and 0.65 in the medium run (over a one-year period).*

- *Adopting a Phillips-Curve framework that allows us to separate domestic factors from foreign ones, we find that the coefficient of import prices pass-through to inflation is around 0.30. The estimated coefficient of unit labour cost is much larger, at around 0.58. The findings indicate that even for a small open economy such as Hong Kong, domestic factors still dominate inflation dynamics in the medium run. We also find that Hong Kong's unit labour cost is sensitive to inflation expectations, after controlling for domestic demand and external factors.*

- *Combining the estimated coefficients of the first two steps, we find that exchange rate pass-through to domestic prices is about 0.10% in the short run and about 0.20% in the medium run, meaning that a one-per-cent depreciation of the Hong Kong dollar NEER would lead to an increase in domestic prices of 0.1% in the short run and 0.2 % in the medium run.*

- *Put differently, a 10% depreciation of the US dollar against all currencies except for the Hong Kong dollar would cause domestic prices to increase by 0.82% in the short run and 1.61% in the medium run.*

- *Compared with some OECD economies, Hong Kong's exchange rate pass-through to domestic inflation in the medium run is high. For example, exchange rate pass-through to domestic prices was only 0.01% in the US and 0.17% in the OECD economies on average.*

- *The results are cross-checked by a calibration exercise that examines exchange rate pass-through to tradable and non-tradable goods. Although the transmission mechanism of exchange rate pass-through is different from the econometric estimates, we found that the aggregated elasticities to CPI inflation through the channels of tradable and non-tradable goods are similar.*

I. INTRODUCTION

After more than four consecutive years of above-trend growth, Hong Kong's inflationary pressure is on the rise. On a three-month-on-three-month comparison, the annualised rate of CCPI inflation picked up to 4.7% in December 2007 from 1.6% in December 2006, driven by strong domestic demand, rising food and energy prices, and the weakening US dollar. Prior to October 2007, one-off relief measures of the Government had made the headline inflation rate much lower than the underlying inflation rate. These measures have temporarily postponed the rises in headline inflation, but they cannot stem off underlying inflation pressures. Indeed, it is expected that these same underlying factors, especially the weak US dollar, would continue to influence Hong Kong's inflation process in 2008.

As a small open economy under the Linked Exchange Rate System, Hong Kong's domestic inflation may be ultimately influenced by foreign factors in the long run. In particular, the movements of the US dollar with which the Hong Kong dollar is pegged are not only important in influencing the balance of payment, but also important in affecting domestic inflation. In the short and medium term, despite the importance of external factors, local factors also matter importantly for domestic price developments, leading to incomplete exchange rate pass-through.

Exchange rate pass-through refers to the effect of a change in the exchange rate on domestic prices. Pass-through is complete when the response of domestic prices to exchange rate changes is one for one. In general, three factors may determine the extent of pass-through of exchange rate to domestic prices: the pricing behaviour by exporters in the producer countries, the responsiveness of mark-ups to competitive conditions and the existence of distribution costs that may drive a wedge between import and retail prices (Olivei, 2002 and Campa and Goldberg, 2005). In particular, the last two factors tend to work against each other in determining the extent of exchange rate pass-through. For example, with monopolistic competition in import business, mark-ups are highly responsive the exchange rate movement. However, the presence of local distributors may insulate import price pass-through to retail price. This is because local distributors often absorb some exchange-rate volatilities in order to keep price relatively stable at retail level so to maintain or even expand their market shares. While it is not surprising that Hong Kong

should experience incomplete pass-through, the exact nature and contribution of exchange rate pass-through to domestic inflation remain an empirical issue.

Previous studies on Hong Kong's inflation mainly focus on how foreign shocks are transmitted to domestic inflation. Cheung and Yuen (2001) found that consumer price indices in Hong Kong and the US are cointegrated and shocks to US CPI have a strong influence on Hong Kong CPI but with a lag of two years. Genberg and Pauwels (2005) established that underlying shocks in Hong Kong CPI inflation have a foreign origin, while domestic wages and prices determine the transmission mechanism of the shocks. Even during the recent deflation period, the origin of the shocks was still foreign, but the domestic wage adjustment process played a contributing role. These studies suggest that domestic factors play an important role in Hong Kong's inflation dynamics, although external factors are original sources of shocks.

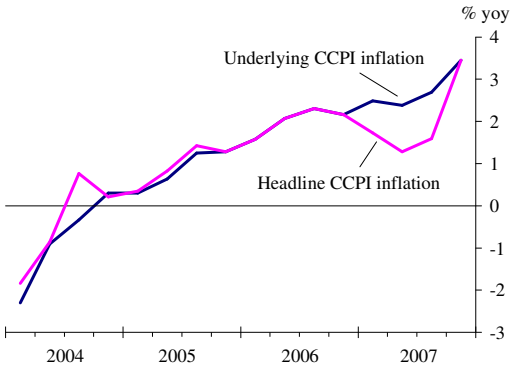
Rather than focusing on the transmission mechanism of Hong Kong's inflation, we investigate the degree of exchange rate pass-through to domestic inflation in Hong Kong. To accomplish this objective, we first investigate exchange rate pass-through to import prices and then assess import prices pass-through to domestic inflation using a Phillips Curve. By combining these two sets of estimates, we are able to obtain estimates of exchange rate pass-through to domestic inflation. These econometric estimates are then cross-checked with a calibration exercise based on a formulation with microeconomic foundations that investigates exchange rate pass-through to domestic inflation via channels of tradable and non-tradable goods.

The rest of the paper is organized as follows: Section II reviews recent developments of Hong Kong's inflation dynamics. Section III investigates exchange rate pass-through to import prices. Section IV quantifies the contribution from both domestic and external factors to inflation dynamics in Hong Kong. Section V calibrates the contribution of exchange rate pass-through to tradable and non-tradable goods. Section VI summaries the empirical findings and concludes.

II. RECENT DEVELOPMENT OF HONG KONG'S INFLATION

Consumer price inflation in Hong Kong has been picking up steadily since mid 2004, following a period of prolonged deflation starting from 1998. The underlying average annual rate of inflation increased to 2.8% in 2007 from 2.0% in 2006. Despite rising underlying inflation, the headline inflation remained subdued at 2.0% in 2007 resulting from one-off relief measures of the Government before October 2007, which had made the headline inflation rate much lower for most part of 2007 (Chart 1). As shown in Chart 1, headline inflation and underlying inflation eventually converged in October, indicating that these measures may have temporarily postponed the rises in headline inflation, but they cannot stem off underlying inflationary pressures.

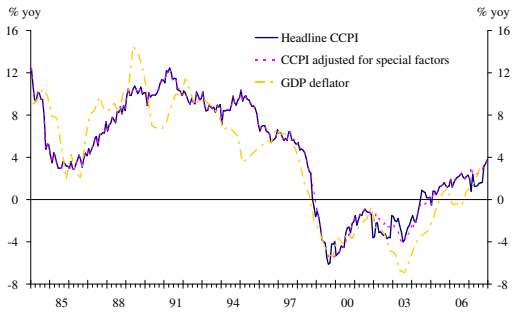
Chart 1: Headline inflation and underlying inflation



Sources: C&SD and staff estimates.

The presence of relatively high inflation is not a new phenomenon in Hong Kong. For most part of the 1980s and the 1990s, inflation in Hong Kong was quite high and volatile (Chart 2).[1] The average consumer price inflation had been 11% two years before the adoption of Linked Exchange Rate System (LERS). It declined to below 5% in the mid-1980s, rose to high single digits in the late 1980s, reached a peak of 12.5% in the spring of 1991, and declined to single high digits before the out-break of the Asian financial crisis. The Hong Kong economy then went

Chart 2: Various measures of inflation



Sources: C&SD and staff estimates.

[1] When analysing developments in domestic prices, CCPI is preferable to the GDP deflator. Although CCPI does not cover investment spending and external trade as in GDP deflator, it is more useful for analysis of domestic price movements because it focuses on domestic consumption behaviour only. In the case of Hong Kong, both CCPI and the GDP deflator share a similar trend in the past two decades (see Peng and Fan, 2004).

into a six-year period of deflation from late 1998.

CCPI can be broadly decomposed into two major components: tradables and non-tradables. The tradable component is defined as the goods imported from the rest of the world, including basic food, electricity, gas and water, alcoholic drinks & tobacco, clothing & footwear, durable goods and miscellaneous goods. The tradable component is relatively high compare to other economies because the manufacturing sector in Hong Kong contributes to less then 10% of GDP. The non-tradable component is defined as services provided domestically. They include meals away from home, housing, transport and miscellaneous services. It appears that increases in consumer prices since mid-2004 were mainly driven by non-tradable component in the CCPI, as residential rents in the non-tradable component have been rising steadily. However, more recently, imported food in the tradable component, especially the latest surges in prices of meat products, dominated the trend of underlying inflation, largely reflecting the effect of the renminbi appreciation, the weakening of the US dollar, and rising energy and food prices globally. This is in contrast to the experiences of the past two decades, as the tradable inflation only contributed to an average of 12% to overall consumer prices movement (Chart 3), after adjusting for its weight in the CCPI basket (Table 1).

Table 1:

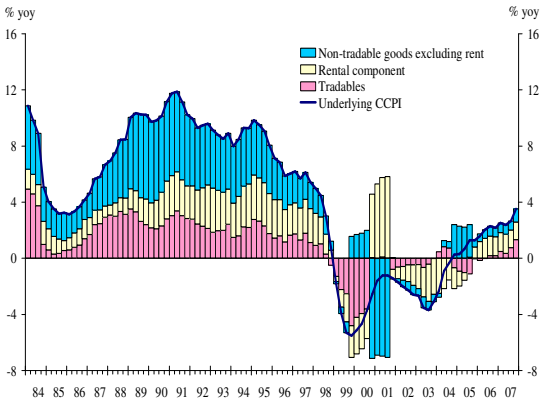
Weights of CCPI components (Base period: Oct 2004 to Sept 2005)

	(%)
Tradable	**28.73**
Basic Foods	*10.08*
Electricity, gas and water	*3.59*
Alcoholic drinks & tobacco	*0.87*
Clothing & footwear	*3.91*
Durable goods	*5.5*
Miscellaneous goods	*4.78*
Non-tradable	**71.27**
Meals away from home	*16.86*
Housing	*29.17*
Transport	*9.09*
Miscellaneous services	*16.15*

Source: C&SD.

Chart 3:

CCPI inflation by components

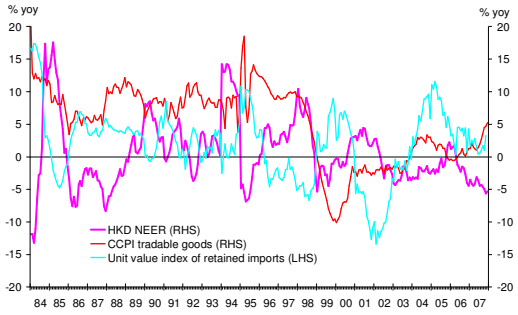


Sources: C&SD and staff estimates.

Recent rises in inflation of tradable goods in the retail level can be partly explained by the increase in border prices of imported products (measured in unit value index of retained imports) (Chart 4). Since February 2002, the US dollar has started to depreciate. The trade-weighted US dollar nominal effective exchange rate (NEER) reached a historical low in 2007. Given the Linked Exchange Rate System, the Hong Kong dollar NEER has also been depreciating steadily. Between February 2002 and December 2007, the trade-weighted nominal effective exchange rate of the Hong Kong dollar had already declined by almost 16%.

Chart 4:

HKD NEER, Import prices and tradable good inflation

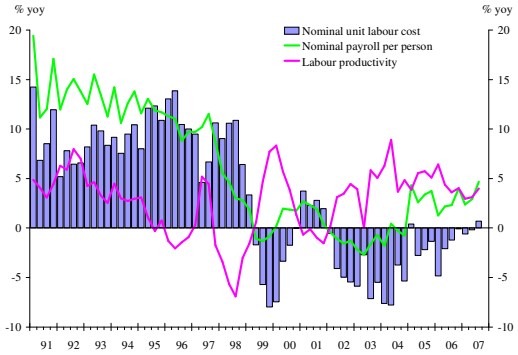


Sources: C&SD and staff estimates.

Prices of non-tradable goods are not only dependent on external factors but also on domestic factors such as labour market conditions and structural factors of the economy. In the case of Hong Kong, as wages are the major part of the service sector costs,[2] the unit labour cost is a good representative for local factor costs. In addition, as all marginal costs from different factor inputs should be equalized at the margin in a competitive economy, unit labour cost can be treated as a measure of marginal cost of domestic production (Olivei, 2002). However, the change in unit labour cost has been modest in recent years, suggesting inflationary pressure from wage increases remained limited. Indeed, strong labour productivity growth may have kept unit labour costs from rising fast. Growth in labour productivity, measured in output per worker, has been increasing at a year-on-year rate of 4.9% on average since 2003 Q3 (Chart 5).

Chart 5:

Labour productivity and labour costs



Sources: C&SD and staff estimates.

[2] During 1984-2005, wages shared 42% of costs in service sector in Hong Kong.

III. EXCHANGE RATE PASS-THROUGH TO IMPORT PRICES

Recent studies indicate that exchange rate pass-through to import prices has experienced a significant decline in OECD countries over years. Olivei (2002), for example, found that pass-through in the United States was 0.50 on average in the 1980s and it dropped to an average of about 0.25 in the 1990s. This means, other things being equal, a one-percent US dollar depreciation would translate into a 0.50 percent increase in import prices in the 1980s, while in the 1990s, the increase was only 0.25 percent. Similar trend is also observed for a group of OECD economies, though the evidence is mixed over types of goods and countries (Campa and Goldberg, 2006b).

Following the framework of Campa and Goldberg (2006a, b) on the relationship between import prices and exchange rate after adjusting for foreign production costs and domestic demand factors, we estimate the elasticity of pass-through from exchange rate to import prices using the quarterly Hong Kong data for the period of 1984 to 2007. Specifically, the exchange rate pass-through equation can be written as follows:

$$\Delta \ln(PM_t) = \beta_1 + \sum_{i=0}^{4} \beta_{2i} \Delta \ln(NEER_{t-i}) + \sum_{i=0}^{4} \beta_{3i} \Delta \ln(FPC_{t-i}) + \varepsilon_t \qquad (1)$$

where PM_t, $NEER_t$, and FPC_t refer to import prices, Hong Kong dollar nominal effective exchange rate, and foreign production costs of Hong Kong's key trading partners.[3] As a convention in the exchange rate pass-through literature, domestic demand pressures should also affect import prices. However, given Hong Kong is a very small open economy, it has no pricing power in the international market. Hence, domestic demand from Hong Kong is assumed to have no impact on import prices, though import prices do affect Hong Kong's domestic prices. The short-run (contemporaneous) elasticity between import prices and NEER is given by estimated coefficient β_{20}. The medium-run (over one year) elasticity of the same relationship can be obtained by summing the coefficients of contemporaneous exchange rate change and four lags of exchange rate

[3] Foreign production costs are approximated using the equation, $w_t^* = (NEER_t / REER_t) * PM_t$, where w_t^* is foreign wage and NEER and REER refer to the IFS definition of neu and reu (Campa and Goldberg, 2006b). The term $(NEER_t / REER_t)$ is in fact a measure of the foreign unit labour cost relative to the local cost. Therefore, w_t^* is defined as marginal product of labour (approximated by relative unit labour cost) multiplying by import prices. To check for robustness, we also use foreign producer prices (trade-weighted average among trading partners) to construct the REER. The results are presented in Table 2.

terms $\sum_{i=0}^{4} \beta_{2i}$. We also first difference these variables to control for potential unit roots.

The estimation results of equation (1) are summarised in Table 2. We find that the pass-through elasticity is at around 0.33 in the short run and 0.65 in the medium run for the full sample period from 1984 to 2007. This implies that, other things being equal, a one percent depreciation of Hong Kong dollar nominal effective exchange rate (NEER),[4] would lead to an increase in import prices at the border by about 0.3 percent in the short run and by about 0.6 percent in the medium run. When splitting the sample, we find that pass-through of both short-run and medium-run is higher for the period of 1984 to 1991 than those for the period of 1992-2007. For example, up to 1991, exchange rate pass-through in Hong Kong is slightly over 0.8, indicating a pass-through of close to 80% within one year, whereas it declines to 0.45 for the period of 1992 to 2007. Indeed, this finding also confirms the experiences in OECD economies found in Campa and Goldberg (2006b). The choice of 1991 as a demarcation line reflects the fact that most of Hong Kong's manufacturing establishment has moved to the Mainland after 1991. Note that Hong Kong's manufacturing industry mainly produces for exports with large import contents, especially in terms of energy and raw materials. Campa and Goldberg (2005) suggested that the exchange rate pass-through elasticity to imports prices is usually high for energy and raw materials but relatively low for imported food products and manufacturing goods. Therefore, the decline in manufacturing industry and hence the imports for energy and raw materials in Hong Kong can partly explain the decrease in exchange rate pass-through to import prices in the latter period.

Furthermore, compared to the existing estimates from other economies, Hong Kong's pass-through elasticity appears to be more sensitive to changes in exchange rate in the medium run, possibly reflecting the small country effect and the lack of capacity for imports substitution from domestic sources. Indeed, these two factors may also explain the high impact of foreign production cost on import prices, as the coefficient is about 0.8 for the full sample.

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[4] The Hong Kong dollar NEER is calculated using trade weights of our key trading partners. The trade weights of our key trading partners are: Mainland China, 22.4%; US, 17.9%,; Japan,11.7%; Euro area, 11.5%; Taiwan, 6.5%; Singapore, 5.8%; S. Korea, 6.1%; UK, 5.5%; Malaysia, 2.7%; Thailand, 2.4%; Canada, 1.9%; Australia, 2.4%; Philippines, 1.7%; and Switzerland, 1.4%. Although the Hong Kong dollar is pegged to the US dollar, movements in the US dollar against other currencies may have different impact on HKD NEER. For example, if the USD depreciates by one percent against all other currencies, the HKD NEER would depreciate by 0.82%. Similarly, a one percent of RMB appreciation against the US dollar would lead the HKD NEER to depreciate by 0.22%.

Table 2: Pass-through elasticities of exchange rate to import prices

2a) Foreign wage as a proxy of foreign producer cost				
		1984-2007 (full sample)	1984-1991	1992-2007
		(Dependent variable: import prices)		
Constant		-0.004 **	0.001	-0.007 ***
		(2.5)	(0.4)	(3.5)
NEER	β_{20} (short run)	-0.33 ***	-0.43 ***	-0.31 ***
		(5.0)	(4.9)	(3.6)
	$\sum_{i=0}^{4}\beta_{2i}$ (medium run)	-0.65 ***	-0.82 ***	-0.45 **
		[34.1]	[49.8]	[6.3]
Foreign wage (control variable)		0.85 ***	0.69 ***	0.93 ***
		[59.5]	[8.3]	[52.2]
Adjusted R^2		0.56	0.57	0.59

2b) Foreign producer prices as a proxy of foreign producer cost				
		1984-2007 (full sample)	1984-1991	1992-2007
		(Dependent variable: import prices)		
Constant		-0.001	0.004	-0.004
		(0.4)	(1.4)	(0.9)
NEER	β_{20} (short run)	-0.27 ***	-0.36 ***	-0.24 **
		(3.3)	(3.9)	(2.2)
	$\sum_{i=0}^{4}\beta_{2i}$ (medium run)	-0.80 ***	-0.84 ***	-0.67 ***
		[37.4]	[34.5]	[9.7]
Foreign producer prices (control variable)		0.81 **	0.50	0.99 *
		[6.4]	[2.8]	[3.9]
Adjusted R^2		0.40	0.53	0.35

Note: T-statistics are in parenthesis and F-statistics for those summations of coefficients are in brackets. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.

Source: Staff estimates.

IV. DETERMINANTS OF HONG KONG'S INFLATION: DOMESTIC VS. EXTERNAL FACTORS

To gauge pass-through of import prices to domestic inflation, we use a simultaneous equation system that allows us to disentangle domestic factors from external ones. This approach has been used to investigate inflation process in Australia by Gruen, Pagan, and Thompson (1999). Specifically, the two equation system can be expressed as follows:

$$\Delta \ln(P_t) = \alpha_1 + \alpha_2 MA_n \Delta \ln(ULC_t) + \alpha_3 MA_n \Delta \ln(PM_t) + \varepsilon_{1,t} \tag{2}$$

$$\begin{aligned} \Delta \ln(ULC_t) = {} & \alpha_4 + \alpha_5 \Delta \ln(P^e_{t+1}) + \alpha_6 gap_{t-i} + \alpha_7 \Delta \ln(PM_{t-i}) \\ & + \alpha_{7a} DCrisis * \Delta \ln(PM_{t-i}) + \varepsilon_{2,t} \end{aligned} \tag{3}$$

$$\text{where} \quad \Delta \ln(\hat{P}^e_{t+1}) = (1-\delta)\sum_{i=0}^{n} \beta_i \Delta \ln(P_{t-i}) + \delta \Delta \ln(P^*_{t+1}) \tag{4}$$

where P_t, ULC_t, and PM_t in equation (2) are *CCPI*, the unit labour cost, and import prices, respectively; Δ stands for the first difference of the variable; MA_n represents n-period moving average; P^e_{t+1}, gap_{t-1}, and *DCrisis* in equation (3) are inflation expectations, Hong Kong's real GDP gap estimated from a production function, and a dummy variable to reflect a possible structural break factor associated with the collapse of domestic demand after the 1997-98 financial crisis. Inflation expectation in equation (4) is estimated by combining a backward-looking component with a forward-looking measure.[5] In fact, the system of equations (2) to (4) can also be written as a new Phillips Curve, *à la* Galí and Gertler (1999). When (3) and (4) are substituted into (2), the system of equations becomes a reduced form equation that relates price inflation to import price changes, past inflation, past unit labour costs, past import prices, and forward-looking inflation expectation.

In equation (2), domestic inflation is modeled in such a way that it is a function of both domestic and foreign factors. The domestic factor is primarily represented by the unit labor cost, which is defined as nominal wages per person divided by output per person. In equation (3), the unit labour cost is in turn

[5] Given Hong Kong does not have the inflation expectation survey data, only the backward-looking component is used. Inflation expectations can be estimated by an autoregressive model, a random walk specification, and a leading indicator forecasting model as shown in Liu, Chang, and Tsang (2006). Table 4 shows that these different formulations do not appear to affect the interpretation of the findings much.

determined by inflation expectation, GDP gap, and import prices. Note that in this two-equation framework, foreign factor is only represented by import prices. This is because as a small open economy, import prices affect domestic factors such as inflation expectations via wage bargaining and eventually the unit labor cost; but Hong Kong's domestic factors cannot affect import prices. This two-equation system is then estimated jointly using the estimation method of seemingly unrelated regressions (SUR).

The advantages of using SUR are as follows: given import prices also affect the unit labour cost but not vice versa, the coefficient estimates may be potentially inefficient in Equations (2) and (3). However, SUR has a nice property that its estimators are efficient when these two equations are estimated simultaneously. In addition, the unit labour cost variable in Equation (2) has already embodied the effect of import prices. Therefore, coefficients of the unit labour cost and import prices in Equation (2) can be interpreted as the effect of their own on domestic inflation.

The estimation results are presented in Table 3. Our model estimates show that the coefficient of import prices pass-through to inflation is in a range between 0.29 and 0.30, depending on the formulation of the inflation expectation variable. The estimated coefficient of the unit labour cost is much larger, which is in a range of 0.56 and 0.58. The findings appear to have indicated that even for a very small open economy such as Hong Kong, domestic factors still dominate inflation dynamics in the medium run. In the equation of the unit labour cost, both domestic demand factors such as the output gap and external factor such as import prices are important determinants for the unit labour cost. In addition, it appears that inflation expectation has a close relationship with the unit labour cost, as the coefficient is in a range between 0.76 and 1.0 depending on the formulation of inflation expectation. This suggests that Hong Kong's unit labour cost is highly sensitive to inflation expectation after controlling for both domestic demand and external factors of the economy.

Table 3: Estimation results of the system equations for inflation dynamics

	Model A*	Model B*	Model C*
		Inflation equation	
Constant	0.003	0.003	0.003
	(0.001)	(0.001)	(0.001)
$MA_4(\Delta ln(ULC_t))$	0.581	0.575	0.564
	(0.050)	(0.050)	(0.051)
$MA_4(\Delta ln(PM_t))$	0.290	0.288	0.301
	(0.060)	(0.060)	(0.062)
Adjusted R^2	*0.56*	*0.56*	*0.57*
		Unit labour cost equation	
$\Delta ln(P^e_{t+1})$	1.022	1.061	0.758
	(0.139)	(0.148)	(0.134)
gap_{t-4}	0.150	0.135	0.152
	(0.051)	(0.052)	(0.053)
$\Delta ln(PM_{t-4})$	0.241	0.208	0.347
	(0.136)	(0.138)	(0.139)
$DCrisis*\Delta ln(PM_{t-4})$	-0.396	-0.329	-0.369
	(0.211)	(0.212)	(0.222)
Adjusted R^2	*0.28*	*0.31*	*0.32*

Note*: Model A, B, C are based on the different price expectation ($\Delta \ln(P^e_{t+1})$) formed by an autoregressive model, a random walk model, and an indicator model, respectively. Standard errors are in parenthesis.

Source: Staff estimates.

Exchange rate pass-through to domestic inflation: By combining the estimates in sections III and IV, we are able to calculate exchange rate pass-through to domestic inflation. In the short run and for the whole sample, a one percent depreciation of the Hong Kong NEER would lead to a 0.10% (0.33*0.30) increase in domestic prices, holding other things constant, in the case of foreign wage being used as the foreign production cost indicator. Similarly, in the medium run and for the whole sample, one percent depreciation of the Hong Kong dollar would lead to a 0.20% (0.65*0.30) increase in domestic prices, again holding other things constant. If using exchange rate pass-through estimates for the latest period (1992-2007), we find that exchange rate pass-through has decreased for both the short run and medium run respectively, being 0.09% and 0.13% for one percent of increase in Hong Kong's NEER. Indeed, exchange rate pass-through to domestic prices also appears to have declined marginally (Table 4).

These results also imply that the depreciation of the Hong Kong dollar NEER was an important factor in the development of inflation in Hong Kong. For example, between 2002 and 2007, the Hong Kong dollar NEER depreciated by about 16%. If we apply the estimates for the latest period (1992-2007), the US dollar depreciation is calculated to have pushed up the average annual inflation rate by about 0.4 percentage points over the last 6 years. For the 2007 CPI inflation, the estimated contribution due to the depreciation of the Hong Kong dollar NEER were 0.6 percentage points, or about over 20% of underlying inflation in 2007. Note that these are direct effect owing to changes in exchange rate, although the changes in exchange rate also affect the unit labour cost indirectly through the cost channels such as import prices, which in turn influence the unit labour costs via inflation expectations.

Table 4: Pass-through elasticities of exchange rate to CCPI (Inflation expectation formed by indicator model)

	1984-2007 (full sample)	1984-1991	1992-2007
Foreign wage as a proxy of foreign producer cost			
Short run	0.10	0.13	0.09
Medium run	0.20	0.25	0.13
Foreign producer prices as a proxy of foreign producer cost			
Short run	0.08	0.11	0.07
Medium run	0.24	0.25	0.20

Source: Staff estimates.

V. EXCHANGE RATE PASS-THROUGH TO THE TRADABLE AND NON-TRADABLE GOODS: A CALIBRATION ANALYSIS

Previous sections examine overall exchange rate pass-through to overall domestic prices. A natural follow-up question is: What is the magnitude of exchange rate pass-through to the prices of tradable and non-tradable goods? This section investigates this question using a calibration analysis. The calibration approach has a microeconomic foundation that explicitly tracks the degree of substitutability of imported and domestic products and presents the explicit cost functions faced by producers. Using the theoretical framework derived in Obstfeld and Rogoff (2000), Corsetti and Dedola (2005) and Campa and Goldberg (2006a), the formulation of exchange rate pass-through to consumer prices can be summarized as follows.

$$P_t(N) = \frac{\theta}{\theta - 1} c_t(N) = \frac{\theta}{\theta - 1}\left[\frac{W_t}{Z_N} + \mu_t(N:e)\frac{eW_t^*}{Z_T}\right] \tag{5}$$

$$P_t(T) = \frac{\theta}{\theta - 1} e_t c_t^*(T) = \frac{\theta}{\theta - 1}\left[\frac{eW_t^*}{Z_T} + m_t(T:e)P_t(N)\right] \tag{6}$$

where P_t(N) is the price for non-tradable goods and P_t(T) is the price for imported tradable goods;[6] both domestic labour and imported inputs are used for non-tradable goods and labour inputs required per unit of output ($\frac{W_t}{Z_N}$ for domestic provided non-tradables and $\frac{e_t W_t^*}{Z_T}$ for foreign imported tradables) are derived to be inversely related to stochastic productivity parameters Z_i. W_t refers to wages per domestic labour and W_t^* wages per foreign labour. Productivity parameters, domestic wages, and foreign wages are all assumed sticky. Imported input shares per unit of output are denoted by $\mu(N{:}e)$ for domestic production on non-tradables. These imported cost shares are assumed to be sensitive to exchange rates e. As a convention, foreign currency variables are indicated by a superscript "*".

As in Burstein et al (2003) and Corsetti and Dedola (2005), there are also distribution costs associated with tradable goods. These distribution expenditures are permitted to be sensitive to the exchange rate e, which is defined as the domestic cost per unit of foreign exchange. Thus, the marginal cost of distributing the tradable goods is

$$m(T:e) = \left[\int_0^1 m(k)^{\frac{\theta-1}{\theta}}\,\mathrm{d}k\right]^{\frac{\theta}{\theta-1}}, \tag{7}$$

Since all tradable goods use the same distribution inputs, the distribution costs are therefore equal among goods. Note that θ is the elasticity of substitution among tradable goods.

[6] In Hong Kong, manufacturing is only a small share of total production, and the products are mainly for exports. Therefore, we may simply assume all the tradable goods are imported from other regions.

Differentiating equations (5) and (6) with respect to exchange rate, *e*, we can derive exchange rate pass-through elasticities for both tradables and non-tradables as follows:

Non-tradables:

$$\eta^{P_t(N),e_t} = \frac{\partial P_t(N)/\partial e_t}{P_t(N)/e_t} = (1+\eta^{\mu_t(N:e),e_t})\left[\frac{\mu_t(N:e)\frac{e_t W_t^*}{Z_T}}{c_t(N)}\right] = \frac{\theta}{\theta-1}(1+\eta^{\mu_t(N:e),e_t})\left[\frac{\mu_t(N:e)\frac{e_t W_t^*}{Z_T}}{P_t(N)}\right] \tag{8}$$

Tradables:

$$\eta^{P_t(T),e_t} = \frac{\partial P_t(T)/\partial e_t}{P_t(T)/e_t} = 1 - \frac{\theta}{\theta-1}\frac{(m_t(T:e)P_t(N))}{P_t(T)}\left[1-(\eta^{m_t(T:e),e_t}+\eta^{P_t(N),e_t})\right] \tag{9}$$

Exchange rate pass-through to CCPI is then aggregated using a CES function for consumer price, P_t:

$$P_t = [\alpha P_t(T)^{1-\phi} + (1-\alpha)P_t(N)^{1-\phi}]^{\frac{1}{1-\phi}}, \tag{10}$$

where α is the share for tradable price (the weight of tradable goods in CCPI basket), $P_t(T)$, and $(1-\alpha)$ is the share for non-tradable price, $P_t(N)$. Pass-through of exchange rate into the aggregate CPI can then be derived by

$$\eta^{P_t,e_t} = \alpha\left[\frac{P_t(T)}{P_t}\right]^{1-\phi}\eta^{P_t(T),e_t} + (1-\alpha)\left[\frac{P_t(N)}{P_t}\right]^{1-\phi}\eta^{P_t(N),e_t}, \tag{11}$$

Equation (11) indicates that aggregate pass-through to CPI is a weighted average of pass-through elasticities of both tradable and non-tradable goods. These two elasticities are state-contingent and dependent on relative wage and productivity parameters in domestic and foreign markets (Obstfeld and Rogoff, 2000).

Based on the framework presented above, we can then calibrate the pass-through elasticities. The calibration requires some parameter values for elasticity of substitution among differentiated products (θ), distribution costs per unit of output ($m_t(T{:}e)$), imported input share per unit of non-tradable output ($\mu(N{:}e)$), pass-through elasticity of exchange rate to distribution cost ($\eta^{m_t(T:e),e_t}$),

pass-through elasticity of exchange rate to the imported input share per unit of non-tradable output ($\eta^{\mu_t(N:e),e_t}$), mark-up rate between tradable and non-tradable goods, ($\phi/(\phi-1)$), and labour inputs required per unit of output of foreign imported tradable goods, ($\frac{e_t W_t^*}{Z_T}$).[7]

Given the lack of certain parameters for the Hong Kong economy, we have to make some assumptions in order to calibrate the pass-through elasticities.[8] These assumptions are in both Table 5 and Table 6. Specifically, Table 5 shows the assumptions using OECD averages and Table 6 presents some Hong Kong specific assumptions.

[7] For labour inputs required per unit of output of foreign imported tradable goods, we use Hong Kong dollar NEER for the exchange rate e; foreign wages (W_t*) is defined as in footnote 3, and the stochastic productivity parameters Zi is proxied by the share of total factor productivity to potential output. Details calculation of total factor productivity can be found in Ha and Leung (2001).

[8] Most of these parameters can be gathered from an input-output table. However, the Census and Statistics Department does not produce the input-output table for the Hong Kong economy.

Table 5: Assumptions for calibration (using OECD average)

Variable	Assumption	Rationale	Sensitivity
Elasticity of substitution among tradable goods (θ)	4	In Hong Kong, services sector dominates the economy. The elasticity of substitution among tradable goods should be lower. Thus a lower θ is assumed in the calibration.	The higher elasticity of substitution among tradable goods, the larger the pass-through.
Distribution costs per unit of output ($m_t(T{:}e)$)	0.40	Average of OECD countries (0.40 for household consumption only, and 0.16 for overall).	The higher distribution costs, smaller pass-through; as the presence of local distributors may insulate import price pass-through to retail price.
Imported input share per unit of non-tradable output ($\mu_t(N{:}e)$)	0.13	Average of OECD countries (0.13 for non-tradables only, and 0.25 for overall). The imported input share should be low for Hong Kong given its service sector domination.	The higher imported input share, larger pass-through.
Pass-through elasticity of exchange rate to distribution cost ($\eta^{m_t(T:e),e_t}$)	-0.3	Average of OECD countries is –0.257. $\eta^{m_t(T:e),e_t}$ for Hong Kong should be very small given its territory size.	The higher negative value in $\eta^{m_t(T:e),e_t}$, the smaller pass-through, particularly for tradables.
Pass-through elasticity of exchange rate to the imported input share per unit of non-tradable output ($\eta^{\mu_t(N:e),e_t}$)	0	Baseline assumptions in Campa and Goldberg (2006b) are either 0 or -0.1. In general, this pass-through elasticity is sensitive to exchange rate for manufacturing. However, given service sector domination, the share of imported input should be small and should not be sensitive to exchange rate. Therefore, we assume this pass-through elasticity be 0.	$\eta^{\mu_t(N:e),e_t}$ is either 0 or negative. Higher negative value in $\eta^{\mu_t(N:e),e_t}$, the smaller pass-through, particularly for non-tradables.
Mark-up rate between tradables and non-tradables ($\phi/(\phi$-1))	1	We simply use the baseline assumption in Campa and Goldberg (2006b), as the non-tradable goods in Hong Kong are mainly services, which can't be substituted by tradables.	The higher mark-up rate, the larger the pass-through.

Source: Campa and Goldberg (2006b) and staff estimates.

Table 6: Assumptions for calibration (using Hong Kong specific inputs)

Variable	Assumption	Rationale	Sensitivity
Elasticity of substitution among tradable goods (θ)	4	Same as in Table 5.	The higher elasticity of substitution among tradable goods, the larger the pass-through.
Distribution costs per unit of output ($m_t(T{:}e)$)	0.30	Lower than Table 5. This is calculated by using the share of transport & storage and wholesale & retail trades to GDP, multiplying the average ratio distribution costs per unit of consumption to distribution costs per unit of aggregate output in OECD	The higher distribution costs, smaller pass-through; as the presence of local distributors may insulate import price pass-through to retail price.
Imported input share per unit of non-tradable output ($\mu_t(N{:}e)$)	0.20	Higher than in Table 5. We use the share of retained imports of raw materials, capital goods and fuel to GDP.	The higher imported input share, larger pass-through.
Pass-through elasticity of exchange rate to distribution cost ($\eta^{m_t(T:e),e_t}$)	-0.5	The average value of OECD countries is –0.257 and the baseline assumptions of Campa and Goldberg (2006b) are either 0 or -0.5. As a small economy with limited geographic territory, Hong Kong's distribution cost is small. Given foreign trade dominance, the share per unit of tradable goods is volatile as the import prices of tradable goods are sensitive to exchange rate changes (as indicated by Table 2). Therefore, a high elasticity (-0.5) is assumed.	$\eta^{m_t(T:e),e_t}$ should be 0 or negative. Higher negative value in $\eta^{m_t(T:e),e_t}$, the smaller pass-through, particularly for tradables.
Pass-through elasticity of exchange rate to the imported input share per unit of non-tradable output ($\eta^{\mu_t(N:e),e_t}$)	0	Same as in Table 5.	$\eta^{\mu_t(N:e),e_t}$ is either 0 or negative. Higher negative value in $\eta^{\mu_t(N:e),e_t}$, the smaller pass-through, particularly for non-tradables.
Mark-up rate between tradables and non-tradables ($\phi/(\phi$-1))	1	As the non-tradables in Hong Kong are mainly services, which can't be substitute by the tradables.	The higher mark-up rate, the larger the pass-through.

Source: Campa and Goldberg (2006b) and staff estimates.

Table 7: Exchange rate pass-through into CPI

Calibration	
Assumptions of using OECD average	
Aggregate CCPI	0.19
via: Tradable channel	*0.17*
Non-tradable channel	*0.02*
Hong Kong specific assumptions	
Aggregate CCPI	0.23
via: Tradable channel	*0.20*
Non-tradable channel	*0.03*
Memorandum Item	
Estimation results in Section IV	
Aggregate CCPI	*0.20*

Source: Staff estimates.

Based on these assumptions, exchange rate pass-through via the tradable and non-tradable goods is calibrated in Table 7. It is not surprising that the elasticities calibrated for the tradable goods are much higher than the non-tradable goods. Specifically, the calibrated results show that exchange rate pass-through is mainly via tradable goods (more than 80%), which is in line with the expectation. These pass-through elasticities using the OECD averages are generally smaller than those using the Hong Kong specific assumptions. These results, particularly when using Hong Kong specific assumptions, are not much different from our econometric estimates as shown in Table 4, which is in a range of 0.20 to 0.24 for the sample period of 1984-2007. However, one has to be cautious in making a comparison between these two sets of data, given many assumptions involved in the calibrated exercises.

VI. SUMMARY AND CONCLUDING REMARKS

The elasticity of exchange rate pass-through to import prices in Hong Kong is estimated at around 0.31 in the short run (next quarter) and 0.45 in the medium run (over a one-year period) for the sample period from 1992 to 2007. For the sample period between 1984 and 1991, the elasticities are estimated to be 0.43 for the short run and 0.82 for the medium run. For the sample period as a whole (1984-2007), the elasticities are estimated to be 0.33 for the short run and 0.65 for the medium run.

Applying a Phillips-Curve framework that allows us to disentangle domestic factors from foreign factors, we find that the coefficient of import prices pass-through to inflation is in a range between 0.29 and 0.30, depending on the formulation of the inflation expectation variable. The estimated coefficient of the unit labour cost is much larger, which is in a range of 0.56 and 0.58. The findings appear to have indicated that even for a very small open economy such as Hong Kong, domestic factors still dominate inflation dynamics in the medium run.

Using these elasticity estimates and multiplying them by the estimated coefficient of import prices to domestic inflation obtained from the Phillips-Curve framework, we can then obtain exchange rate pass-through to domestic inflation. The estimated pass-through coefficients are in a range of 0.09%-0.13% in the short run and 0.13%-0.25% in the medium run, meaning that a one-percent depreciation Hong Kong dollar NEER would lead to an increase in domestic prices of 0.09-0.13 and 0.13-0.25 percent in the short run and medium run, respectively. These estimates suggest that the degree of pass-through decreased in the second sample period. In comparing to the existing estimates for some OECD economies, Hong Kong's exchange rate pass-through in the medium run to domestic inflation is relatively high. For example, exchange rate pass-through to domestic was only 0.01% for the US and 0.17% for the OECD average (Campa and Goldberg, 2006a), reflecting Hong Kong as a small open economy and the lack of capacity for import substitution from domestic sources.

The econometric estimates are then cross-checked using a calibration exercise that allows for exchange rate pass-through to domestic prices via the channels of both the tradable and non-tradable goods. We find that pass-through elasticities for tradable goods are much larger than those for non-tradables. However, the overall pass-through elasticities to CPI via the channels of tradable and non-tradable goods are in the range of 0.19 to 0.23. These estimates are also generally larger than the averaged OECD range of 0.02 to 0.18.

This paper provides a comprehensive analysis of exchange rate pass-through to import prices and then to domestic inflation in Hong Kong. While it is possible that other channels, other than import prices, may also affect Hong Kong's domestic inflation, this remains a research topic to be explored further.

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